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SUMMARIZATION REPORT OF THE TECHNICAL ASPECTS OF THE 1962 WESTERN HEMLOCK LOOPER CONTROL PROJECT AT ASTORIA, OREGON

by

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C O N T E N T S

INTRODUCTION

In the summer of 1962, a cooperative project was undertaken by the State of Oregon Department of Forestry, Industry, and the U. S. Forest Service to control a serious infestation of the western hemlock looper, Lambdina fiscellaria lugubrosa Hulst., on 32,531 acres of hemlock timber in Clatsop County, Oregon. A cooperative egg survey in late 1961 and early 1962 helped delineate the boundaries of the infestation.[1/] Treatment was 1/2 pound of technical grade DDT dissolved in 0.625 quarts of an auxiliary solvent diluted in #2 fuel oil to make 1-1/2 gallons per acre.

The area was primarily private and State land. The cost sharing for the project was:

Federal Government - 100% of costs on federal lands
25% of costs on private lands

State of Oregon - 100% of costs on State, county and municipal lands
37½% of costs on private lands

Private Landowners - 37½% of costs on private lands

The following is the breakdown of the spray area by ownerships:

State, County, Municipal	7,321 acres
Private	24,877 acres
Federal	333 acres
	32,531 acres

The spray area consisted of forested land divided by rivers, timber type, etc., into four distinct units which were named Clatsop Unit, Youngs River Unit, Astoria Unit, and Gnat Creek Unit. To facilitate ease in project direction, these plots were divided into the following spray blocks:

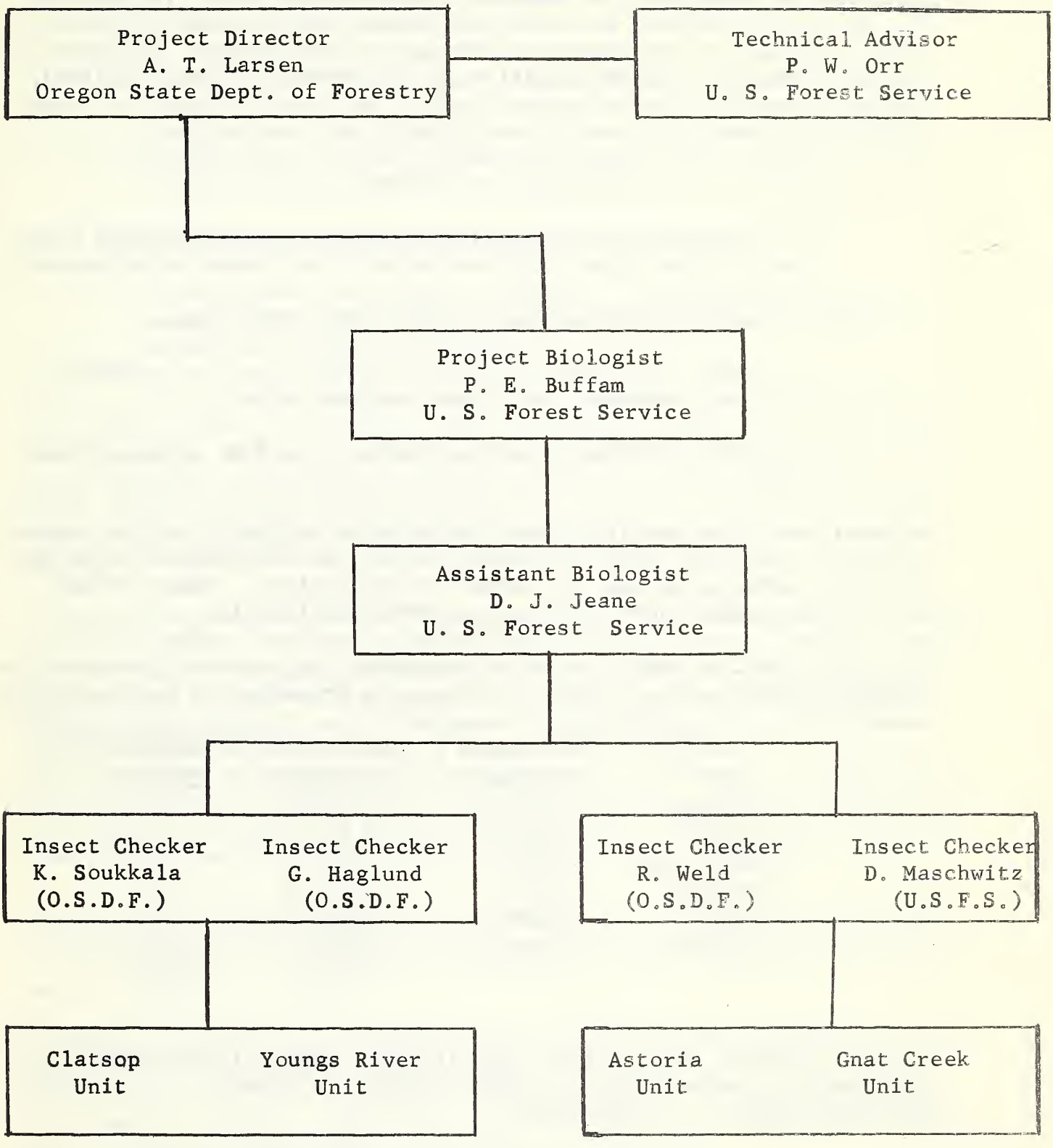
Unit	Spray Blocks	Acreage
Clatsop	1, 2	5,858
Youngs River	3, 4, 5, 6, 7	12,883
Astoria	8, 9, 10, 11	9,898
Gnat Creek	12, 13	3,892
		32,531

1/ Buffam, P. E. and J. C. Braidwood. Report on the 1961 western hemlock looper egg survey in Clatsop, Columbia, and Tillamook Counties of Oregon. U. S. Forest Service, Region 6, 17 pp. November 1962.

The State of Oregon Department of Forestry administered the direction of the 1962 project, and the U. S. Forest Service provided technical guidance. A. T. Larsen, Insect and Disease Control Branch, Oregon State Department of Forestry, was the Project Director. Entomologists P. W. Orr and P. E. Buffam, Insect and Disease Control Branch, U. S. Forest Service, were in charge of the technical program (see Figure 1).

This report summarizes the work accomplished and data gathered by the technical staff on the 1962 western hemlock looper control project.

Figure 1.--Technical organization chart of the 1962 western hemlock looper control project.



TECHNICAL PROGRAM

The technical phase of the 1962 western hemlock looper spray project began on May 15 when P. E. Buffam, Project Biologist, established a laboratory-office at the Oregon State Department of Forestry Office in Astoria. D. J. Jeane, Assistant Biologist and four insect checkers reported to work June 5 to complete the technical staff (Figure 1). The project biologist, assistant biologist, and one insect checker were personnel of the Insect and Disease Control Branch, Division of Timber Management, Regional Office, U. S. Forest Service, Portland, Oregon. The three other insect checkers were employed by the Oregon State Department of Forestry specifically for this project.

Primary duties of the technical staff were:

1. To determine when the western hemlock loopers in each block were in the right position in the tree crowns to be sprayed.

2. To assess spray coverage within each spray block.

3. To assess the amount of drift, if any, reaching spawning streams, pastures, and other critical areas.

4. To assess hemlock looper mortality caused by spray application.

Methods used to accomplish these duties were set forth in the project technical direction plan.[2/] Several of the methods described in this plan were altered during the course of the project. These changes will be discussed under the sections where applicable.

In total, 264 man-days of work were required by technical personnel to complete their duties. The following is a breakdown of working time by men:

Man	Date began working	Date ended working	Man-days worked
Buffam	May 15	July 27	61
Jeane	June 5	July 27	41
Maschwitz	June 5	July 27	41
Soukkala	June 5	July 27	41
Weld	June 5	July 27	41
Haglund	June 5	July 25	39
		Total	264

2/ Buffam, P. E. 1962. Plan for the Technical Direction of the 1962 Western Hemlock Looper Control Project in Oregon. U. S. Forest Service, Region 6. (Processed).

PRE-SPRAY LARVAL SAMPLING

To determine the date when spraying should be initiated, four sampling points were established within each spray unit. At each of these points, data on migration of the looper larvae from understory to overstory and larval development were taken. These sampling points, referred to as collection points in this report, were selected in each unit on the basis of at least one or more of the following:

1. Points where 1961-62 winter egg samples were moderate to heavy.

2. Points where looper larval populations were present at the time of establishment.

3. Points where 1961 defoliation was conspicuous.

4. Points where the timber stands were predominately western hemlock over 60 years old, and a heavy understory of hardwoods and conifers prevailed.

Each collection point was visited at least twice weekly. At this time two types of data were taken, looper position in the stand and looper development. According to information acquired during the 1945 looper spray project, looper larvae feed on understory foliage during their first stage of development and then move up the boles of the conifers into the tree crowns. Spray operations should be initiated after this migration occurs.

To determine the position of the loopers in the forest, single branches of five separate understory plants were selected as the sampling media. During the 1962 project, branches of red huckleberry (Vaccinium parvifolium) and tall blue huckleberry (V. ovalifolium), western hemlock (Tsuga heterophylla), and vine maple (Acer circinatum) were sampled. Five branches on each plot were sampled by placing a 3-foot-square beating sheet beneath a branch and shaking or hitting the branch causing the loopers to fall onto the sheet. The loopers were then counted, the number recorded, and the larvae placed back on the same branch so that future sampling from that branch would not be affected.

At the same time the branches were sampled, at least 15 loopers were collected from foliage near the plot, placed in alcohol, and delivered to the biologist or assistant biologist for use in obtaining developmental data.

Originally, plans were to spread a strip of tanglefoot around the base of five hemlocks on the plot and count the number of loopers stuck in this material at each collection time in addition to sampling the five branches.[3/] However, laboratory studies showed that the loopers would walk around the tanglefoot rather than through it.

3/ Ibid.

Results of the beatings are shown in table 1. Sampling began on June 5 and continued through July 6. However, the collection points supporting very light populations of looper larvae were not sampled after June 29 when other phases of the control program demanded more time. Collection points with moderate to heavy looper populations in the Clatsop, Youngs River, and Astoria Units were sampled 11 times. The Gnat Creek Unit was sprayed after the eighth collection was made. The number of larvae per plot per collection time ranged from 0 to 266 with an average of 30.1.

Beatings were taken at 11 of the original 16 plots after spraying to see how many larvae remained on the understory foliage (Table 1). The number of larvae per plot ranged from 0 to 9 and averaged 4.7.

The expected rapid lessening of numbers of looper larvae on the understory branches never did occur. However, a definite downward trend did occur and this, coupled with the fact that loopers could be seen inching their way up the hemlock boles, helped determine when to initiate spraying. One of the problems faced in branch sampling was that increased numbers of loopers would occur on the branches on some plots immediately after a heavy rainfall.

Looper developmental data were taken by collecting at least 15 looper larvae at each collection point at the time the beatings were made. At some collection points, 15 larvae could not be collected in a reasonable length of time for the first few collections, while at others, more than 15 larvae could be collected easily.

The greatest number of looper larvae collected from June 5 through July 6 were in the first instar (Table 2). On July 6, 75 percent of the loopers were still in the first instar. Second instars were first collected on June 12 and increased in numbers until the final collection when they totaled 24 percent of all larvae. A few third instars were collected in the 8th and 10th collections but were never in great numbers.

Table 1.--Number of looper larvae counted from beatings of five understory branches.

Collection point	Looper larvae by collection number												Post-spray beatings
	1	2	3	4	5	6	7	8	9	10	11	Total	
Clatsop													
1	3	15	47	44	108	181	72	94	130	57	46	797	3
2	0	0	1	1	3	3	2	--	--	--	--	10	--
3	0	0	0	0	3	0	0	--	--	--	--	3	--
4	0	0	1	0	0	1	0	0	--	--	--	2	--
Youngs River													
5	8	17	40	78	113	162	128	94	108	62	41	851	4
5A	1	--	9	16	37	55	48	38	32	17	22	275	5
6	2	6	41	75	183	266	217	159	142	112	56	1,259	6
7	0	0	0	1	2	1	0	--	--	--	--	4	--
8	0	1	0	0	0	0	0	--	--	--	--	1	--
Astoria													
9	1	0	3	6	12	29	39	30	34	8	4	166	9
10	12	9	10	10	8	7	5	11	7	6	7	92	--
11	8	6	29	58	72	102	104	98	57	55	38	627	7
12	0	0	1	16	22	30	28	42	45	25	10	219	3
Gnat Creek													
13	0	4	0	3	4	5	3	6	--	--	--	25	0
14	0	4	7	5	8	12	11	9	--	--	--	56	4
15	4	2	3	10	8	8	7	--	--	--	--	42	3
16	4	13	25	33	34	36	26	35	--	--	--	206	8
Total	43	77	217	356	617	898	690	616	555	342	224	4,635	52

Table 2.--Results of larval collections for developmental data by collection number and date.

Instar	Percentage of larvae by collection number and date										
	1 6/5-8	2 6/8-13	3 6/12-15	4 6/14-19	5 6/18-21	6 6/22-26	7 6/26-27	8 6/28-29	9 7/2-3	10 7/5	11 7/6
First	100.0	100.0	99.2	98.6	99.7	98.8	92.0	91.6	90.8	73.3	75.6
Second	-	-	0.8	1.4	0.3	1.2	8.0	8.1	9.2	26.1	24.4
Third	-	-	-	-	-	-	-	0.3	-	0.6	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of larvae collected	86	185	257	294	294	329	266	343	250	179	221

RELEASE OF SPRAY BLOCKS

Spraying began on July 2 and was concluded on July 18. Blocks 2, 12 and 13, the first ones released for spraying, were released on July 2 (Table 3). Although the looper larvae had not completed their migration from understory brush to overstory conifers at this time, looper populations in these three blocks were fairly light; therefore, they could be sprayed a little early without assuming too great a risk. Blocks 6 and 7 were released on July 3 with the same thought in mind. After blocks 2, 12, 13 and most of 6 and 7 were sprayed, no other blocks were released until looper migration was more advanced. As a result, a six-day lay-off was scheduled. Blocks 1, 3 and 4 were released on July 9 and blocks 5, 9, 10 and 11 on July 10. Block 8 was not released until July 16 awaiting clearance from the Federal Aeronautics Association to fly below 1,000 feet over the City of Astoria, a part of which was included in this block.

Table 3.--Dates individual spray blocks were released and sprayed.

Spray Unit	Block No.	Acres	Date Released for Spraying	Date(s) Sprayed
Clatsop	1	2,578	July 9	July 10 and 11
Clatsop	2	3,280	July 2	July 2 and 3
Youngs River	3	1,347	July 9	July 10
Youngs River	4	2,846	July 9	July 10 and 11
Youngs River	5	3,397	July 10	July 10,11,15 and 16
Youngs River	6	3,216	July 3	July 3 and 10
Youngs River	7	2,077	July 3	July 3 and 10
Astoria	8	3,328	July 16	July 16, 17 and 18
Astoria	9	1,832	July 10	July 10,11,15 and 16
Astoria	10	2,933	July 10	July 15,16,17 and 18
Astoria	11	1,805	July 10	July 15,16,17 and 18
Gnat Creek	12	1,581	July 2	July 2 and 3
Gnat Creek	13	2,311	July 2	July 2
Total		32,531		

LARVAL MORTALITY SAMPLING

To assess results of aerial applications of DDT on looper mortality, 13 plots were established within the spray area. Plots were selected at collection points and other accessible areas where looper populations were abundant. Mortality plots were established in all spray blocks except 2, 6 and 7. No accessible areas with abundant looper populations could be found in these three blocks.

At all mortality plots, except number 9A, three trees were selected and numbered for sampling. At plot 9A, ten trees were selected to assess the efficacy of the insecticide Sevin. The trees selected were relatively open-grown dominant, codominant, intermediate, or suppressed western hemlocks that had several branches within 10 to 40 feet of the ground, so that they could be sampled using an aluminum pole pruner. In most instances, the trees were at least 100 feet apart and were not selected in any particular pattern. In some areas, it was very hard to find three trees that fulfilled the requirements previously mentioned; in others it was relatively easy.

Trees on each mortality plot were sampled twice, once before the area was sprayed and once after. Pre-spray sampling was done one to three days before the plot was sprayed and post-spray sampling, seven to ten days after the plot was sprayed. Sampling procedures for pre- and post-spray sampling were the same. Five 18-inch branches were clipped from each of the three plot trees using a pole pruner. The branches were caught in the basket attached to the pole pruner and lowered singly to the ground. Each branch was shaken over a muslin cloth to dislodge the loopers from the foliage. The number of hemlock loopers on the muslin were counted and recorded by branch and tree number. Differences in looper numbers between the pre- and post-spray counts were presumed to be caused by the insecticide applied and were recorded as the percent mortality.

Mortality on the area sprayed with DDT was determined from 11 plots (Table 4). Average mortality was 88.2 percent and ranged from 55 to 100 percent. As mentioned previously, plot 9A was used to test Sevin. Plot 15 was not sampled after spraying because the pre-spray sample failed to yield any looper larvae. Spray deposit cards showed that plots 1A and 10A were only partially sprayed, thus accounting for the low mortality figures on these two plots. Plot 16 was sprayed earlier than the other plots, which may have had some effect in lowering the mortality figures.

Table 4.--Summary of western hemlock looper mortality on plots sprayed with DDT.

Mortality plot number	Spray block number	Pre-spray larval count	Post-spray larval count	Percent mortality
Clatsop MP #1	1	23	0	100.0
Clatsop MP #1A	1	38	17	55.3
Youngs River MP #5	3	104	9	91.3
Youngs River MP #5A	3	77	6	92.2
Youngs River MP #6	4	69	11	84.1
Youngs River MP #6A	5	93	3	96.8
Astoria MP #9	8	167	1	99.4
Astoria MP #10A	10	105	34	67.6
Astoria MP #11	9	63	3	95.2
Astoria MP #12	11	18	1	94.4
Gnat Creek MP #16	12	42	9	78.6
Total		799	94	88.2

Several factors influenced the outcome of the test using the carbamate insecticide Sevin. First, the spray plane flew along the edge of the plot instead of directly over it; thus, only a few trees were directly hit with spray. Secondly, some of the plot trees were hit with DDT spray drift when adjacent areas were sprayed. Mortality in the trees on plot 9A ranged from 11.5 to 98.9 percent and averaged 70.8 percent (Table 5). Tree number 9 was directly sprayed with Sevin, and the mortality figure for this tree may show the killing potential of this insecticide. However, more testing must be done to determine beyond a doubt the efficacy of Sevin as a control of the western hemlock looper.

Table 5.--Western hemlock looper mortality on plot 9A which was partially sprayed by Sevin.

Tree number	Pre-spray larval count	Post-spray larval count	Percent mortality
1	71	4	94.4
2	83	20	75.9
3	68	18	73.5
4	136	96	29.4
5	51	33	35.3
6	111	9	91.9
7	26	23	11.5
8	37	7	81.1
9	93	1	98.9
10	55	2	96.4
	731	213	70.8

COLLECTION TRAY SAMPLING

At seven mortality plots, 3-foot-square collection trays were installed beneath trees before spraying to provide supplemental information. In total, 11 trays were set out at mortality points 1, 5, 6A, 9A, 10A, and 16. The number of dead looper larvae and other Arthropods were counted and recorded at various intervals for a 4 to 13 day period after the plots were sprayed.

The number of dead looper larvae per tray ranged from 27 to 738 with an average of 232.5 (Table 6). The greatest number of loopers were present on the trays within two days after spraying, but some loopers were collected on one tray 13 days after spraying. The tray producing the most dead loopers (738) was beneath the crown of tree 9 of mortality plot 9A. This tree was sprayed with Sevin and was in the midst of the heaviest looper population in the entire project area.

Specimens of nine orders of insects and several miscellaneous Arachnids fell on the trays along with the looper larvae (Table 7). Corrodentia adults were the most predominant, followed by sawfly larvae, unknown looper larvae, mosquito adults, midge larvae, dermestid larvae, and miscellaneous Dipterans and Hymenopterans, in that order. Spiders also were present in moderate numbers. A few specimens of other insects were collected from time to time. Compared to the number of western hemlock loopers on the trays, the number of other Arthropods recorded were negligible.

Table 6.--Daily looper larval collections from 3-foot-square collection trays after spraying.

		Tray	Loopers on 3 x 3 ft. tray by number of days after area was sprayed														
	MP#	No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
7-11	1	1	177	93	33	--	--	34	--	9	--	3	--	--	1	--	350
7-10	5	1	36	--	41	7	--	--	0	--	--	--	--	--	--	--	84
7-10	6A	1	101	--	94	11	--	--	17	--	7	--	1	--	--	0	231
		2	193	--	208	23	--	--	29	--	9	--	6	--	--	4	472
7-18	9A	1	156	192	38	--	--	21	--	9	--	4	--	--	--	--	420
		2	--	565	96	--	--	72	--	4	--	1	--	--	--	--	738
7-18	10A	1	40	6	4	--	--	2	--	3	--	0	--	--	--	--	55
		2	69	6	13	--	--	10	--	2	--	3	--	--	--	--	103
	16	1	10	--	--	13	--	--	--	--	--	--	--	--	--	--	23
7-3	16A	1	6	--	--	21	--	--	--	--	--	--	--	--	--	--	27
		2	9	--	--	45	--	--	--	--	--	--	--	--	--	--	54
			797	862	527	120	--	139	46	27	16	11	7	--	1	4	2,557

Table 7.--Summary of Arthropods other than the western hemlock looper found on 3-foot square collection trays.

Class	Order	Family	Life stage	Relative abundance
Insecta	Lepidoptera	Geometridae	Larva	Moderate
		Miscellaneous	Larva	Light
		Miscellaneous	Adult	Light
	Diptera	Culicidae	Adult	Moderate
		Itonididae	Adult	Light
		Itonididae	Larva	Moderate
		Tipulidae	Adult	Light
		Miscellaneous	Adult	Moderate
	Hymenoptera	Tenthredinidae	Larva	Moderate
		Chalcidae	Adult	Light
		Miscellaneous	Adult	Moderate
	Coleoptera	Dermestidae	Larva	Moderate
		Chrysomelidae	Adult	Light
		Buprestidae	Adult	Light
	Ephemeroptera	Ephemeridae	Adult	Light
	Thysanura	Lepismatidae	Adult	Light
	Hemiptera	Miscellaneous	Adult	Light
	Corrodentia	Miscellaneous	Adult	Heavy
	Dermaptera	Miscellaneous	Adult	Light
Arachnida	Miscellaneous	Miscellaneous	Adult	Moderate

SPRAY DISTRIBUTION

A total of 542 oil-sensitive spray deposit cards were used on the 1962 Western Hemlock Looper Project. Some cards were placed on the mortality plots and beside critical spawning streams within the spray area to determine spray coverage. Others were placed in critical forage fields and pastures of dairy farms and around reservoirs bordering the spray boundaries to determine if spray drift occurred.

Spray deposit cards were either placed in wire holders or nailed to the top of fence posts. Most of the cards were suspended 40-50 inches above the ground in holders made of galvanized wire. 4/ This placed the cards above the height of the dense understory plants, allowed moisture to run off readily, and allowed them to dry off quickly. Some of the cards placed in pastures and forage fields were nailed to fence posts to keep the cards free from destruction by livestock. After treatment, the cards were collected and the amount of spray deposit estimated by comparing them with a set of standards. 5/

The estimated amount of spray on individual spray deposit cards placed on the mortality plots ranged from 0.0 to 1.50 gallons per acre. The average on the total 129 cards was 0.26 gallons per acre (Table 8). Some of the cards were not placed in big enough openings in the stand, so the surrounding tree foliage sheltered out some of the spray and lowered the estimated spray deposit values. Estimated spray deposit at the Gnat Creek Weir ranged between 0.20 to 0.75 gallons per acre and along Tucker Creek between 0.1 and 0.3 gallons per acre; however, no fish mortality was observed. Cards placed at the side of other streams bordering the spray boundary showed that no spray had drifted onto the streams where the cards were located. Spray deposit cards were placed in forage fields of 17 farms to check spray drift. Cards at only one of the farms, Oregon State University's John Jacob Astor Branch Experiment Station (State Farm), showed appreciable amounts of insecticide. Here, the estimated spray deposit ranged from 0.0 to 0.2 gallons per acre.

4/ Maksymiuk, B. Improved Holders for spray deposit cards. Journal of Economic Entomology; 52(5) 1029-30. October 1959.

5/ Davis, J. M. Standards for estimating airplane spray deposits on oil-sensitive cards. Forest Service, U. S. Department of Agriculture, Washington 25, D. C., 1954.

Table 8.--Estimated spray deposit on oil-sensitive dye cards placed within the spray area and in adjacent critical areas.

Location	No. Cards	Estimated Range		Ave. Estimated Deposit	
		Gal./Acre	Lb.DDT/Acre	Gal/Acre	Lb.DDT/Acre
Within Spray Area					
MP 1	10	0.2-1.0	0.1-0.3	0.6	0.2
MP 1A	10	0.0-0.5	0.0-0.2	0.1	0.0+
MP 5	10	0.1-0.5	0.0+-0.2	0.2	0.1
MP 5A	11	0.1-0.8	0.0+-0.3	0.3	0.1
MP 6	10	0.0-0.4	0.0-0.1	0.2	0.1
MP 6A	10	0.0-0.4	0.0-0.1	0.2	0.1
MP 9	10	0.0-1.5	0.0-0.5	0.5	0.2
MP 10A	14	0.0-0.2	0.0-0.1	0.1	0.0+
MP 11	10	0.1-1.5	0.0+-0.5	0.5	0.2
MP 12	11	0.2-7.5	0.1-2.5	0.5	0.2
MP 15	10	0.0-0.3	0.0-0.1	0.2	0.1
MP 16	13	0.0-0.2	0.0-0.1	0.0+	0.0+
Reservoirs					
Warrenton	6	0.0-0.1	0.0-0.0+	0.0+	0.0+
East Astoria	10	0.0-0.2	0.0-0.1	0.1	0.0+
West Astoria	5	0.0-0.0	0.0-0.0	0.0	0.0
Lakes and Streams					
Cullaby Lake	5	0.2-0.3	0.1-0.1	0.2	0.1
Gnat Cr. Weir	9	0.2-0.8	0.1-0.3	0.3	0.1
Tucker Creek	6	0.1-0.3	0.0+-0.1	0.2	0.1
Farms					
Oja	10	0.0-0.1	0.0-0.0+	0.0	0.0
Smith	21	0.0-0.1	0.0-0.0+	0.0	0.0
Laukkenen	4	0.0-0.0+	0.0-0.0+	0.0	0.0
Sarkie	17	0.0-0.0+	0.0-0.0+	0.0	0.0
Burkhart	21	0.0-0.1	0.0-0.0+	0.0	0.0
Lindgren	5	0.0-0.0	0.0-0.0	0.0	0.0
Olson	17	0.0-0.3	0.0-0.1	0.1	0.0+
Hartill	13	0.0-0.0	0.0-0.0	0.0	0.0
Heino	22	0.0-0.0+	0.0-0.0+	0.0	0.0
Fisher	8	0.0-0.0+	0.0-0.0+	0.0	0.0
Oman	4	0.0-0.8	0.0-0.3	0.4	0.1
Kraft	5	0.0-0.0	0.0-0.0	0.0	0.0
Anderson	8	0.0-0.4	0.0-0.1	0.1	0.0+
Kraft-Anderson	7	0.0-0.0	0.0-0.0	0.0	0.0
Johnson	13	0.0-0.0	0.0-0.0	0.0	0.0
Winters	26	0.0-0.0+	0.0-0.0+	0.0	0.0
Warila	10	0.0-0.0	0.0-0.0	0.0	0.0
State	92	0.0-0.2	0.0-0.1	0.1	0.0+
	473 [6/]				

6/ 69 of the original 542 cards were destroyed by animals, humans, and the weather.

HOST PLANTS OF THE WESTERN HEMLOCK LOOPER

During the project, a list was compiled of the host plants of the western hemlock looper. Looper larvae were observed feeding on the following plants:

1. Western hemlock (*Tsuga heterophylla*)
2. Sitka spruce (*Picea sitchensis*)
3. Red alder (*Alnus rubra*)
4. Vine maple (*Acer circinatum*)
5. Red huckleberry (*Vaccinium parvifolium*)
6. Tall blue huckleberry (*V. ovalifolium*)
7. Red elderberry (*Sambucus callicarpa*)
8. Salmonberry (*Rubus spectabilis*)
9. Thimbleberry (*R. parviflorus*)
10. Bracken fern (*Pteridium aquilinum*)
11. Sword fern (*Polystichum munitum*)
12. Foxglove (*Digitalis purpurae*)
13. Manzanita (*Arctostaphylos* sp.)
14. Salal (*Gaultheria shallon*)
15. Oxalis (*Oxalis* sp.)
16. False Tansy (*Senecid* sp.)

Apparently western hemlock looper larvae will feed on all types of foliage present in the forest during epidemic infestations. Where light to moderate looper populations occurred in the project area, larvae fed mainly on the foliage of western hemlock, red alder, vine maple, red huckleberry, tall blue huckleberry, and salmonberry. Beatings of red alder branches were especially productive in most instances.

RECOMMENDATIONS FOR FUTURE HEMLOCK LOOPER PROJECTS

The following recommendations are included in this report in the hope that they will aid future project biologists:

1. Number of trees sampled on the mortality plots should be increased from three to five. This will give a truer picture of mortality because variance will be reduced.

2. Post-spray mortality counts should not be taken until at least eight to ten days after an area is sprayed. The residual effect of DDT lasts at least eight days unless a heavy rain has occurred.

3. Use new spray deposit cards for testing spray coverage. Spray droplets do not show up plainly on cards that have been stored for any length of time.

4. Place spray deposit cards in wire holders whenever possible. Moisture from rain or fog rolls off cards mounted in wire holders easily; the cards dry out quickly because they are suspended in air; and the wire holders prevent card curling.

5. When spray deposit cards are placed on fence posts, nail all four corners down. This prevents card curling. Cards used on the 1962 project were nailed through the center and some curled badly. These cards were of little value for assessing spray coverage.

6. Spray deposit cards should be placed in an area the day before spraying and picked up immediately after spraying. This prevents any excessive damage to the cards by rain, fog, animals, or humans.

7. Clear-cuts adjacent to heavy infestations should be included within the spray area. During the 1962 project, heavy looper populations were found on plants growing in clear-cuts near heavy infestations. These loopers could complete their larval period in the clear-cut, pupate, and emerge as moths, and the moths could lay their eggs in adjacent stands of timber.

8. The project biologist's headquarters should be near the headquarters of the project director, so that constant contact can be made. Communications were excellent during the 1962 project because the project biologist and project director met at least once a day.

9. If insecticides or other control measures are to be tested on small areas, the boundaries should be well marked using helium-filled balloons, etc. to avoid a mix-up similar to the one that occurred on the 1962 project.

10. Spray cards should be placed in large openings to give a true picture of spray deposit. Some cards on the 1962 project were placed in small openings where surrounding trees shielded the cards. The spray reaching these cards was not indicative of the true spray deposit.